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ABSTRACT

This guide presents the "minimum teaching essentials" published by the New York City Board of Education, for science education in grades 9-12. Covered are: biology, physics, earth science, and chemistry. Work study skills for all subjects are given with content areas, performance objectives, and suggested classroom activities. (APM)

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MAY 2 6 1981

0/4 EXPERIMENTAL EDITION

MINIMUM LEARNING ESSENTIALS

Science

Chemistry Earth Science Biology Physics

General Science

U.S. DEPARTMENT OF EDUCATION
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MAY 2 6 1981

Foreword

High schools throughout the City of New York offer a wide range of enrichment and specialized courses to meet the needs of their students. Courses, both basic and specialized, vary from class to class, depending on the combination of challenge and creativity of the individuals involved. Within this rich variety, there is a need to establish minimum standards based on performance objectives within a subject area which can be used citywide to validate course content and student performance. This experimental series, Minimum Learning Essentials, has been developed to help teachers and supervisors identify the skills and knowledge which students in Grades 9-12 must acquire. The Minimum Learning Essentials, described here in a framework of performance objectives, represents the core of skills and knowledge students must acquire no matter where the course is taken.

The importance of this instructional framework is underscored by the need for increased articulation between and within departments in junior high schools and in high schools, and by the rate of pupil mobility in our city.

It is our intention to extend the concept of Minimum Learning Essentials to all subject areas. The first series comprises the following:

ENGLISH/COMMUNICATION ARTS, Grades 9-12
Eight semesters emphasizing:

- Listening and Speaking
- Literature and Reading
- Writing, including Writing Conventions

MATHEMATICS

- Fundamentals of Mathematics (Grade 9)
- Algebra
- Geometry

SCIENCE

General Science (Grade 9)
Biology
Chemistry
Physics
Earth Science

SOCIAL STUDIES

American Studies
Economics
Global History

As teachers and supervisors test the performance objectives in the coming year, it is vital that they evaluate these objectives for scope and appropriateness. Minimum Learning Essentials is experimental; feedback from teachers and supervisors using these materials is crucial to their future development.

Our society requires increasing skills and competencies of its citizens; the response of the educational community must be to develop the best possible standards for identifying and evaluating what we demand of our students. We can offer no less.

Charlotte Frank,
Executive Director

Overview

In the course of their high school careers students in New York City are required to complete two years of science courses selected from among general science, biology, chemistry, physics, and earth science. This document serves to establish the minimum learnings which students are required to master while they are enrolled in specific high school science courses. In effect, Minimum Learning Essentials: Science establishes the skeleton of a citywide standard curriculum in science.

The content of each science course is constructed sequentially using performance objectives. These objectives are written in terms of what the student should be able to do in order to demonstrate mastery of a particular topic. Suggested activities for each topic provide a starting point from which individual teachers can begin to develop appropriate classroom activities. Teachers and supervisors should feel free to expand upon the performance objectives and suggested activities presented in order to fit the needs and abilities of their students. Activities may also be adopted according to the availability of facilities, supplies, and visual aids within a given school. In addition, a codification of work study skills applicable to all sciences appears at the beginning of this document.

How to Use This Bulletin

Minimum Learning Essentials is a set of suggested instructional objectives for high school science. Those instructional objectives are stated in terms of student performance. Written in a basic, elemental fashion, these objectives are designed to be tailored by individual teachers to meet their own instructional needs.

It is important to know:

a. what is meant by a performance objective;
b. how performance objectives relate to traditional instruction, i.e., to the developmental lesson; and
c. what options are available to teachers in shaping performance objectives.

The following distillation of principles and procedures for the development and use of performance objectives will help teachers and supervisors develop and use performance objectives in the science curriculum.

Performance Objectives: A Definition

As used here, the term performance objective* describes what a student is expected to know or do. It defines precisely what knowledge, understanding, and skills the student will learn and demonstrate. In general, these objectives are stated at a simple degree of specificity and do not pretend to detail the conditions under which the learning is demonstrated nor the criteria for evaluating success. In spite of this simple degree of specificity (see chart, p. x), these objectives serve two purposes.

1. They provide an emphasis on student performance (i.e., what it is the student is expected to do).

2. They serve as a starting point for the development of more intricate, complex, and detailed performance objectives.

* Readers familiar with the performance objectives movement will recognize the contributions of Benjamin Bloom and Robert Mager in the ensuing discussion. A more detailed treatment of these substantive issues and their effect on the New York City school system is presented in Performance Objectives: Experimental Edition available from the Division of Curriculum and Instruction. This brief discussion is offered to help teachers and supervisors get started working out their own performance objectives.

Performance objectives, then, always address themselves not to teacher behavior but to student behavior. They may be stated at low or high degrees of specificity. They are defined as: the intended terminal behavior on the part of students which is the intended result of an instructional activity.

Performance Objectives and Traditional Instruction

The teachers who prepared this material have paid considerable attention to the inclusion and sequencing of material, but have not provided complete lesson plans. A good lesson plan must include an aim, a motivation, development, applications, activities, and summaries. It is left to the individual teacher to develop these plans, using the performance objectives as guides.

Objectives written in terms of student performance are not new to traditional instruction. In a developmental lesson, for example, the aims of the lesson (and frequently the ancillary aims) addressed themselves to student performance....but not always and not consistently. A good point of departure for incorporating performance objectives into traditional instruction is the analysis of developmental lesson plans. Teachers will find that performance objectives may be utilized as aims, ancillary aims, student aims, medial summaries, and even as suggested follow-up and enrichment activities, without harming the integrity of the traditional lesson format. Their incorporation therein will have the effect of putting a greater emphasis on student results and learning competencies. The motivation, pivotal questions, and evaluation may then be more precisely and consistently targeted onto the desirable and intended outcomes of the class.

Shaping Performance Objectives

Shaping performance objectives may be as simple or as complex as the situation requires. For the most part, in the present document we deal only with cognitive objectives (i.e., those which detail intellectual performances) leaving affective behaviors for a future treatment.

In writing performance objectives for science, we try to avoid verbs such as "learn," "know," "appreciate," "think," etc., which are difficult to observe and measure. Through the careful selection and wording of performance objectives, however, the kind of thinking required is implied. If students can state a relationship, write a formula expressing the relationship, and use the relationship to solve particular types of problems, then it can be assumed that they understand the relationship at several levels of thinking.

Rather than focus in on the extremely complex myriad of intellectual competencies desirable on the part of students, three cognitive behaviors* serve for this beginning discussion. They are:

I. knowledge (i.e., simple recall, recognition, identification, etc.);

II. understanding (i.e., comprehension, inference, translation, etc.);

III. utilization (i.e., application, analysis, synthesis, evaluation, etc.).

The "compression" of intellectual activity into these three broad categories is not arbitrary. Rather, it is presented on the basis of substantial classroom experience. Thus, before students can really understand (II) density, there are certain terms and principles which they will have to know and recall (such as mass and volume). Thus cognitive behavior (simple recall of knowledge once achieved) permits behavior II, understanding; On the basis of achievement in I and II, performance III, utilization, is possible, e.g., the calculation of density from known information.

The objectives for science as presented cover this range of three cognitive behaviors. Teachers may choose to shift from one behavior level to another. For example, if the objective specifies a level II performance (infer, translate) it may be more productive for a certain class to recall prior knowledge and for the teacher to rephrase the performance objective in terms of knowledge (I).

* Teachers who are involved in Mastery Learning are familiar with the use of instructional objectives classified according to levels of cognitive behavior based on Benjamin Bloom's Taxonomy of Educational Objectives.

In addition to emphasizing three cognitive behaviors, the objectives in science are presented to assist teachers in the development of more complex, more individualized objectives which are appropriate to a specific class. Professional experience has pointed out that performance objectives may be stated in at least four degrees. These degrees form a continuum which moves from the general to the specific.

DEGREES OF SPECIFICITY

degree 1	degree 2	degree 3	degree 4
The statement of the "interior" intellectual behavior intended for learner achievement (*i.e.*, to identify).	The statement of an "overt" behavior on the part of the students from which the "interior" behavior can be inferred (*e.g.*, to write).	The delineation of the overt behavior detailing the "conditions" under which the behavior will be achieved (for example, to write from memory, without the text).	The delineation of the overt behavior detailing not only the conditions under which it will be achieved but also detailing the "criteria" for success (*e.g.*, to write from memory correctly four out of five times).

Any one of the objectives offered in this guide can be completed in various ways to suit the needs of individual teaching settings. For example, a performance objective might read:

> The student will be able to name and locate the parts of a flower.

An analysis of this objective reveals that it calls for a cognitive Level III performance on the part of the student -- viz., utilization. As such, teachers can choose to accept it or to "move it back" to Level I or II, depending on the achievement level of the class. If it is accepted as presented, teachers can then choose to give it more

performance detail. As stated, it speaks to the "overt" behavior, (i.e., to write) from which can be inferred the "interior" behavior, utilization. To move to degree 3 of statement specificity, the teacher, in detailing conditions of performance, may choose to write:

> Given several flowers, the student will identify the parts without using a textbook.

Moving on to the fourth and final degree of specificity of statement, should it be desirable, the teacher can add criteria of successful performance: Thus.

> Given several flowers, the student will identify the parts correctly in four out of five cases without using a textbook or chart.

Thus, this simple statement of overt behavior on the part of the student can be used as the basis for the development of an even more precise (i.e., conditioned and criterioned) statement of the same objective.

Getting Started

Given a clear notion of what a performance objective is, teachers are encouraged to incorporate them into their day-to-day planning and delivery of instruction. To begin, it is suggested that three cognitive behaviors

I. knowledge
II. understanding
III. utilization

be the initial focus. At the same time, four degrees of statement specificity are available -- i.e.,

1. interior performance
2. overt performance
3. overt with conditions
4. overt with conditions and criteria.

The minimum learning essentials in science are set forth on the pages that follow; individual schools may wish to include topics or objectives that have been omitted. Teachers can expand upon these performance objectives by providing review, explanations, illustrations, and enrichment activities of their own design.

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Work Study Skills

Work-study skills are those which students require in order to study, to work in class individually or in small groups, to do homework assignments. These skills are listed for each mathematical discipline in order to focus teachers' and supervisors' attention on elements which might be taken for granted. If we tell students to do more work, to study harder, we must be sure that the students know the skills that make their studying effective. It is hoped that an increased teacher awareness of the components of science work-study skills will translate into increased skills and general competency for our students.

WORK STUDY SKILLS CHART

Students acquire skills through using them consistently in assignments relating to the science curriculum. For skills which require the use of library resources, librarians cooperate with classroom teachers on how specific skills may be applied to topics teachers plan to teach.

The following chart identifies the major work/study skills and the grade level at which they should be emphasized.

	9	10	11	12
FOLLOWING DIRECTIONS				
·Taking notes from oral directions requiring several steps	■	■	■	■
·Applying a pattern for following written directions:				
··Reading title	■	■	■	■
··Reading for overview	■	■	■	■
··Rereading for specific steps	■	■	■	■
··Carrying out steps	■	■	■	■
··Checking for correct completion	■	■	■	■
·Applying skills in following directions to situations that reflect real needs in outside world:				
··Assembling scientific apparatus	■	■	■	■
··Assembling kits (radio, TV, computer)	■	■	■	■
··Caring for and handling animals	■	■	■	■
··Safely using chemicals, drugs, and household appliances	■	■	■	■
·Independently following complex directions which require research skills:				
··Assembling laboratory equipment and conducting experiments	■	■	■	■
LOCATING AND COLLECTING DATA FROM VARIOUS SOURCES				
·Making observations using the senses	■	■	■	■
·Using electronic and audiovisual recording equipment	■	■	■	■

	9	10	11	12
*Using computer technology				■■■■■■■■■■■■
*Interpreting and rephrasing questions; narrowing topics; selecting key words to aid in location of information	■■■■■■■■■■■■■■■■■■■■■■■■			
*Interviewing	■■■■■■■■■■■■■■■■■■■■■■■■			
Using reference sources	■■■■■■■■■■■■■■■■■■■■■■■■			
**Dictionary				
**Scientific encyclopedias and periodical indexes				
**The American Association for the Advancement of Science Booklist				
*Scanning for specific information; skimming for overview	■■■■■■■■■■■■■■■■■■■■■■■■			
*Using format in printed material (table of contents, copyright date, glossary, index, chapter and topic headings, bibliography)	■■■■■■■■■■■■■■■■■■■■■■■■			

SELECTING, RECALLING, EVALUATING INFORMATION

*Appraising sources for relevance and reliability	■■■■■■■■■■■■■■■■■■■■■■■■			
*Determining what data is necessary to solve a problem	■■■■■■■■■■■■■■■■■■■■■■■■			
*Refining skills in selecting and integrating significant information from multiple sources	■■■■■■■■■■■■■■■■■■■■■■■■			
*Using organized study methods such as SQ3R:			■■■■■■■■■■■■■■■■■■■■	
S - Surveys the chapter title, topic and subtopic headings to pick up the main ideas of the chapter				
Q - turns each topic into a question				
R - rapidly reads the material to answer questions				
R - recites or recalls the answers to questions previously posed or to questions at the end of the chapter				
R - reviews the material by constructing an outline for further study or by writing a summary				

*Librarians will help plan which specific sources are best for a particular assignment.

	9	10	11	12
ORGANIZING INFORMATION				
*Refining skills in notetaking	■	■	■	■
*Extending outline technique to the third level	■	■	■	■
*Preparing footnotes and bibliographies	■	■	■	■
*Isolating a problem and relevent data from a large quantity of material		■	■	■
*Excerpting, classifying and/or categorizing more complex information from several sources in a variety of media		■	■	■
*Drawing logical and consistent conclusions from assembled data		■	■	■
USING GRAPHIC REPRESENTATION AND INVESTIGATIVE TOOLS				
*Using a variety of measurements to investigate problems and support hypotheses		■	■	■
*Interpret data presented in maps, graphs, diagrams, tables, and charts	■	■	■	■
*Manipulating complex laboratory equipment in investigating problems		■	■	■

General Science

BASIC SKILLS

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
SCIENTIFIC METHOD		
Development	Describe how Francesco Redi disproved the theory of spontaneous generation.	Summarize Redi's experiment.
	Formulate a list of steps in the scientific method based on Redi's work.	List the steps in the scientific method indicating: a) asking a question (problem), b) making a guess (theory), c) checking the guess (experiment), d) describing what happens (observation), e) answering the original question, and f) using the information gained and raising new questions (application.)
	State the importance of having a control in an experiment.	Read the description of several experiments and identify the control in each one.
Application	Conduct an experiment following the steps in the scientific method.	Observe a demonstration in which a bunsen burner is lit while a wooden match is suspended in the center of the cylinder. Answer the following questions: a) What did you expect to happen? b) Why did you expect this? c) What actually happened? d) What can you conclude about the center of a flame? e) How can you apply this information when heating a test tube of water or bending glass?

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
MAKING OBSERVATIONS		
The Sense Organs	Identify how the sense organs help us make observations.	Try to identify various objects while blindfolded. What clues did you use?
The Eye	Write a brief description of how the human eye works.	Observe a model of the eye. Label a diagram of the eye and trace how an image is formed.
	Identify how vision defects such as near sightedness, farsightedness and cataracts may be corrected.	Research the causes of visual defects such as near and far sightedness.
The Ear	Describe how the ear enables us to hear sound.	Label a diagram of the human ear. Trace the path of sound waves through the ear.
MEASURING AND RECORDING DATA		
	Give examples to illustrate why we cannot depend solely on our senses to make accurate observations.	Observe several optical illusions and discuss how they were created.
	Accurately measure and record length, volume, and weight in metric units.	Practice obtaining accurate measurements using a metric ruler, graduated cylinder and triple beam balance.
	Use a Celsius Thermometer to determine the temperature of liquids.	Practically measure the temperature of water as it is being heated.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
MEASURING AND RECORDING DATA		
	Convert Celsius to Fahrenheit measurements.	Practice using formulas to convert ^{o}F to ^{o}C and ^{o}C to ^{o}F.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
THE NEEDS OF LIVING THINGS		
Basic Needs	Define living things as those organisms that grow, reproduce, and obtain energy from food.	Observe an aquarium. Discuss how non-living things are differentiated from living things.
	Differentiate between living and non-living things.	
	List the special needs of living things including air, water, food, and proper temperature.	Design a planting project to illustrate the needs of green plants.
	Compare the methods by which plants and animals meet their basic needs.	Prepare a chart that lists the needs of plants and animals; indicate how each need is met.
	Identify the nutrients necessary to sustain human life.	Identify good sources of the basic nutrients. Plan a balanced diet for a week.
Population Growth	Identify factors that limit the size of populations such as starvation, overpopulation, and disease.	Develop a growth curve for human populations, showing increases and decreases in the population of a given area.
	Define carrying capacity as the number of organisms that can live in an area without natural factors limiting the population size.	Report on the story of the Kaibab deer. Discuss the ways in which populations are limited.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Identify those factors which limit the survival of an organism such as light, moisture, and temperature.	Observe and compare plants having different light requirements. Measure the pH of different types of soil and relate it to the types of life found in that soil.
INTERRELATIONSHIPS OF LIVING THINGS		
Energy	Explain why living things need energy.	Discuss the need for nutrient agar as a medium for bacterial growth. Examine an aquarium or a terrarium to determine how the energy needs of the ecosystem are met.
Consumers	Recall that animals are consumers because they eat plants or other animals. Compare various methods used by animals to get food. Identify a predator as an animal that hunts for food.	Observe photographs of various animals and discuss the methods they use for obtaining food. View films and filmstrips which deal with this topic.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Food Chains	Define a food chain as a cycle in nature in which organisms are dependent on each other for their food.	Examine charts of food chains. Given the names of specific organisms, develop an original food chain.
	Identify decomposers as organisms that feed on wastes and decaying matter.	Observe a decomposing log.
Symbiosis	Distinguish between free living and symbiotic relationships.	Observe a sample of lichen.
Protection	Explain the necessity of natural camouflage.	Observe a hermit crab in an aquarium. Observe photographs of the chameleon, walking stick and other organisms that protect themselves by camouflage.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
DISEASE		
Infectious Disease	Define infectious disease as a kind of body disorder which is contagious and is caused by a living organism.	
Causes	Name some infectious diseases that currently trouble humans.	Prepare a scrapbook of newspaper clippings, magazine articles and/or brochures which describe diseases that affect humans most often.
	List some common disease-producing organisms.	Develop a chart of disease-causing organisms and associated diseases.
		Examine bacterial growth on an agar plate that has been exposed to air.
	Identify pathways through which disease-producing organisms may enter the body. Give examples of organisms which enter through each pathway.	Observe agar stabs of aerobic and anaerobic bacteria to compare the conditions under which they live.
		Prepare a microscope slide of tartar from the teeth and observe some mouth bacteria.
Transmission	Identify several methods by which infectious diseases are transmitted including droplet infection, direct contact, and sexual contact.	Discuss why certain diseases spread rapidly through a school, family or group of friends.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Defenses	Identify the body's lines of defense against disease.	Through readings and diagrams, determine how the following body defenses operate: skin, mucous membranes, ciliated epithelium, gastric juice, white blood cells and antibodies.
		Find out how cigarette smoking affects the defenses of the body.
	Recall the smallpox experiment of Edward Jenner and relate it to today's methods of preventing disease.	Read an account of Jenner's smallpox experiment. How does a vaccination strengthen the body's defenses against disease?
	Evaluate the roles of cleanliness, rest, diet, exercise and regular medical care in helping to maintain a health body.	Research the role of good health habits in disease prevention.
Non-Infectious Diseases	Distinguish non-infectious diseases from infectious diseases. Give examples of non-infectious diseases.	
Cancer	List the early warning signs of cancer.	Write to the American Cancer Society, Heart Association, or other health organization for literature. Write a short report on a non-infectious disease.
Heart disease	Name some common diseases and recall those health habits which may affect the occurrence or course of these diseases.	
Deficiency Disease	Evaluate the relationship between diet and deficiency disease.	

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Disease and Population Growth	Evaluate the role of disease as a limiting factor in population growth.	Construct a graph of a human population and show levels of increase and or decrease. Research and report on how modern medical techniques have affected population growth.
LIVING THINGS AND THE ENVIRONMENT		
Animals and Plants	Define an ecosystem as a balanced community composed of both living and non-living things.	Set up a terrarium and an aquarium.
	Contrast terrestrial and aquatic habitats.	View films and filmstrips of animals and plants in their natural habitats. Contrast organisms and their life habits based upon the environment in which they live.
Human Populations	Predict the effects of human overpopulation on the earth.	Develop maps showing areas of concentration of human population.
Pollution	Identify the types of pollution which affect human health such as air, water and noise pollution.	
	Identify the sources of air, water and noise pollution.	Use Petri dishes coated with petroleum jelly to observe particulate matter.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		Observe photographs of waterways destroyed by pollution.
		Collect E. coli bacteria from a water sample using selective media.
	Identify diseases which are related to environmental conditions.	Prepare lists of diseases caused by air, noise, and water pollution. Suggest ways of reducing the problem.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
FLOTATION	Determine whether an object will float or sink in water.	Classify a number of objects according to the prediction as to whether they will float or sink in water. Check the prediction by determining which of the objects actually float or sink in water.
	Predict that an object which weighs less than an equal volume of water will float.	Select an object that floats, and one that sinks. Obtain an equal volume of water by submerging it completely in an overflow can. Weigh the equal volume of water and compare it to the weight of the floating object.
	Predict that an object which weighs more than an equal volume of water will float.	
FORCE AND WORK		
Force	Define force as a push or a pull.	
	Demonstrate that some forces do not produce motion.	Push down against the desk and observe that there is no motion.
	Measure the force with which gravity pulls on an object.	Using a spring balance measure the weights of various objects.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Work	Define work as the result of a force that produces motions.	
	Give examples of forces that produce work and forces that do not produce work.	Raise a book from the floor to the desk. Attempt to lift a door by applying an upward force to the door knobs. Identify the similarities and differences in the actions a force was applied in both cases but resulted in motion on only one occasion.
	Calculate the amount of work done in raising a book from the floor to a desk.	Use a spring balance, measure the force needed to lift a book and a meter stick to measure the vertical distance from a desk. Calculate the amount of work done.
SIMPLE MACHINES	Give examples of levers used as simple machines.	Using only your fingers attempt to lift the lid of a paint can. Then pry it open using a pry-bar or screw driver.
	Demonstrate that a simple machine may be used to decrease the amount of applied force needed to do work.	
	Identify the levers, inclined plane and pulley as simple machines.	Manipulate a variety of devices that incorporate simple machines to do work, e.g., scissors, can opener, pry-bar, ramp, pliers, and pulley.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Identify simple machines incorporated into common objects.	Collect pictures of common objects. Identify the simple machine incorporated into each object.
ENERGY		
Types of Energy	Identify some common forms of energy such as heat, sound, light, electric al, nuclear energy, etc.	Operate a radiometer by means of: a sun light, an electric light bulb and a hot object (iron, soldering gun, boiling water).
	Define energy as the ability to do work.	
Energy Transformation	Give examples of energy being changed from one form to another.	Use a flash light to demonstrate that chemical energy can be changed to electrical energy and then light energy.
	Explain what is meant by the phrase, "energy is conserved."	Cork a flask containing some water. With a Bunsen burner heat the flask until the cork pops. This illustrates the change from chemical energy to heat and light then to motion and sound.
Heat Energy		
Transfer	Describe how heat is transferred by convection, conduction, and radiation.	Do experiments to illustrate convection, conduction, and radiation.
	Demonstrate how heat may be transferred by convection, conduction and radiation.	

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Insulation	Demonstrate that different materials transmit heat at different rates.	Observe a conduction apparatus consisting of rods of various metals and types of wax rings.
	Demonstrate that heat flow can be slowed down by the use of insulating materials.	Compare the drop in temperature of two beakers of hot water measured over a short period of time. One beaker should be insulated and the other not insulated.
Wave Energy	Draw labeled diagrams of transverse and longitudinal waves.	Produce longitudinal waves on a Slinky and transverse waves on a rope.
Sound	Demonstrate that a vibrating object may produce sound.	Hold a ruler against the desk with one end extended over the edge. Snap the extended edge to produce sound. Thrust a vibrating tuning fork into water and observe the results.
	Illustrate that sound waves are longitudinal waves by drawing a diagram showing how a tuning fork produces sound waves.	Touch a ping pong ball, suspended by a thread, to a vibrating tuning fork and observe results.
	Explain why sound cannot travel through a vacuum.	
	Demonstrate how sound can vary in pitch and loudness.	Whistle into a microphone connected to an oscilloscope; observe the relationship of the sound to the wave patterns created.
	Recall that pitch depends on the rate of vibration.	

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Recall that loudness depends upon the amount of energy used to produce it.	
Light	Give examples of light being reflected, transmitted, or absorbed.	Show reflection, transmission and absorption using various objects and a light source.
	Differentiate between regular and diffuse reflection	Observe a group of reflective objects and classify them as to whether they produce regular or diffuse reflections.
	Classify objects as either opaque, or transparent.	Observe squares of aluminum foil, clear plastic, wax paper, white paper, black paper, and glass. Classify as to which objects are opaque, transparent, or translucent.
	Draw a diagram showing the refraction of light as it passes from air to glass.	Observe the apparent bending of a spoon or straw as it is placed into water.
	Draw a labeled diagram of a prism dispersing white light.	Pass white light through a prism and observe the spectrum produced.
	Draw a labeled diagram showing parallel rays of light being brought into focus by a converging lens.	Use a converging (convex) lens to focus a beam of light.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Produce a virtual image with a converging lens.	Place clear plastic on a printed page. Put water drops of various sizes on the plastic. Observe the enlarged virtual images produced.
	Produce a large inverted image with a converging lens.	In a darkened room use a converging lens to produce a large inverted image of a flame on a screen
	Produce a small inverted image with a converging lens.	Using the same equipment as above, produce a small inverted image.
	List devices which produce large inverted images such as a movie or a slide projector.	Collect magazine pictures showing devices which produce large and small inverted images.
Electrical Energy		
Electric current	Define an electric current as the flow of electrons.	Using an ammeter measure the current flowing through various wires.
	Recall that the ampere is the unit for measuring electrical current.	
	Identify voltage as the electrical pressure which causes electrons to flow.	Using a voltmeter measure the voltage produced by a variety of chemical cells.
	Differentiate between a conductor and insulator.	Use an ammeter to measure the electrical current flowing through conductors and insulators.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Construct a circuit which will cause a light bulb to light.	Draw a diagram showing a complete circuit.
Electric circuits	Draw a diagram of two dry cells connected in series.	Connect two dry cells in series and measure the voltage producted using a voltmeter.
	Draw a diagram of two dry cells connected in parallel.	Connect two dry cells in parallel and measure the voltage produced using a voltmeter.
	Draw a diagram of a series circuit showing how a light is turned on and off using a switch.	Construct a series circuit consisting of a switch, bulb, and dry cell.
Heat and light from electricity	Identify devices which can change electric energy into heat and/or light energy.	Observe the heat and light produced by various electrical devices.
Electric motors	List devices which use electric motors to convert electricity into motion (mechanical energy).	Observe various devices which show electric motors which convert electrical energy into motion (mechanical energy).

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
SOURCES OF ENERGY	Name energy sources including fossil fuels, atomic fuels, water, wind and solar power.	Observe and burn coal, oil, and gas.
	Describe how fossil fuels were formed from the remains of living things millions of years ago.	Collect and display pictures of prehistoric life. Report on the formation of coal from life forms existing then.
	Identify the factors contributing to the energy crisis.	Write a report on one aspect of the energy crisis.
Atomic Fuels	Use a diagram or model of a nuclear reactor to explain the process of obtaining energy.	Build a reactor model or draw a cross section, labeling the important parts. Build a reactor model.
Future Energy Sources	List possible energy sources of the future.	Build a simple solar collector which can heat water.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
METEOROLOGY	Differentiate between weather and climate.	Watch demonstrations of weather forecasting instruments.
	Explain how weather and climate affect our ability to grow crops.	Use maps to identify crop-growing regions. Relate the type of crop to the weather and climate of a region.
	Describe how weather and climate affect the distribution of the earth's population.	Prepare written reports on the weather and climate in different biomes.
	Describe how extremes in weather, e.g., hurricanes or snowstorms, can affect the quality of life.	Prepare a scrapbook of news clippings showing the effect of hurricanes, blizzards, etc.
	Use a diagram to trace the water cycle.	Discuss how pollution effects the water cycle.
	Differentiate between an air mass and a front.	Study weather maps; identify fronts and air masses. Discuss how they are used to predict weather.
THE EARTH'S CHANGING CRUST		
Weathering and Erosion	Recall that wind and water are the major agents of weathering and erosion.	Take a field trip around the school community. Observe the effects of weathering and erosion on buildings and sidewalks.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Deposition and Sedimentation	Identify how deposition occurs.	Use a stream table to demonstrate the effects of slope and particle size on deposition.
	Evaluate the relationship between erosion and deposition.	
	Compare and contrast the roles of water in deposition and sedimentation.	Construct a demonstration model which illustrates settling patterns of various sizes of particles.
Rocks	Name the three basic types of rocks.	Examine samples of igneous, metamorphic and sedimentary rock.
	Recall how each type of rock is formed.	
Building Up the Surface		
Volcanoes	Trace the events occurring before, during, and after a volcanic eruption.	View a film or filmstrip describing volcanic eruptions.
Earthquakes	Deduce why earthquakes are considered to be evidence of crustal change.	Prepare a scrapbook or report which documents recent earthquake activity.
Faulting	Define a fault as a weak spot in the earth's crust where movements take place.	Use a map to locate well known faults.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Folding	Define folding as the bending of crustal rocks under pressure.	Examine diagrams which illustrate folding.
THE UNIVERSE		
The Solar System	Correctly label the planets on a diagram of the solar system.	Construct a model of our solar system.
	Differentiate among a sun, moon, and planet.	View films or filmstrips which deal with the origins of heavenly bodies.
	Recall the origins of stars, comets, and meteorites.	
Earth's Movements	Differentiate between rotation and revolution	Use a globe and solar system model to demonstrate revolution, rotation and the relative movements causing day and night and the seasons.
	Analyze how the tilt of the earth and its revolution causes the change in seasons.	
	Analyze how the earth's rotation causes day and night.	
The Moon	Identify the phases of the moon.	Draw diagrams showing the positions of the earth and the moon during each phase.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Tides	Analyze the relationship between gravitational pulls and the tides.	Collect some tide tables from newspapers. Draw a diagram illustrating gravity's affect on the tides.
Eclipses	Construct a model which recreates a solar eclipse.	Observe photographs on an eclipse. Discuss the causes on the dangers of viewing a solar eclipse with the naked eye.
Space Exploration	List the benefits of space exploration to humankind.	View and discuss films on space exploration.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
THE EARTH'S ENERGY RESOURCES		
	List the types of energy available for our use including solar, wind, nuclear and chemical energy.	Present a report on how humankind is served by either wind, nuclear, chemical or solar energy.
	Recall how the sun's energy is stored in plants and fossil fuels.	Discuss why the sun is said to be the source of all energy.
	Suggest ways in which we can conserve our supplies of fossil fuel.	Keep a daily log on your family's energy use. Note any energy abuses and ways of correcting them.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
MATTER		
Solids, Liquids and Gases	Identify each state of matter by its properties.	Observe various sized and shaped solids. See how liquids take on the shape of their containers. Observe colored gases in various containers.
	Read a graduated cylinder.	Take metric measurements of liquids.
	Measure the volume of a regular and an irregular solid.	Measure a regular solid using a metric ruler. Measure an irregular solid using the water displacement method.
	Identify the following pieces of laboratory apparatus: test tube, Bunsen burner, ring stand, test tube rack, test tube holder, beaker, safety goggles, and flask. Safely light a Bunsen burner and handle hot glassware.	Practice setting up laboratory apparatus. Practice safety procedures involving Bunsen burners and hot glassware.
Change of Phase	Read a Celsius thermometer.	
	Identify the conditions that cause a change of phase.	Observe the behavior of ice when melting and water when boiling. Use a thermometer and stop watch to take measurements of the temperature and time involved in the changes of phase. Record all results and observations; graph the results.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Define the following terms: freezing, melting, evaporation, boiling, condensation, and sublimation.	Observe dry ice and discuss the sublimation. Discuss why moth balls seem to disappear over a period of time.
Density	Calculate the density of an object.	Calculate the density of several objects using the formula D= M/V.
Motion of Particles of a Substance	Recognize that solids, liquids, and gases will generally expand and contract as their temperatures are increased or decreased.	Discuss how a thermometer works. Construct a thermometer. Discuss how a thermostat works.
Classes of Matter		
Elements, compounds, and mixtures	Distinguish between an element, compound, and mixture.	Demonstrate the observable properties of elements, compounds and mixtures.
	Classify substances commonly found in the home as elements, compounds, or mixtures.	Collect samples of common household chemicals. Label them and display each with its chemical formula.
Metals and non-metals	Identity substances as metals or non-metals based upon their physical properties.	Demonstrate the electrical and heat conductivity of metals and non-metals.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
ATOMIC STRUCTURE	Draw and label a general atom.	Observe models and diagrams of atoms. Name the particles atoms consist of and locate them.
	Compute the number of protons, electrons, or neutrons in a specific atom.	Practice calculations of proton, neutron, and electron numbers.
	Recall the mass and charge of a proton, neutron, and electron.	
FORMULAS	Name the elements in a compound by reading its formula. Count and identify the number of atoms shown in the formula of simple compounds.	Practice reading chemical formulas and counting the atoms of each element.
	Identify various household substances by their common names. Recall the dangers and uses of household substances.	
	Name common groups (radicals) such as sulfates and phosphates; identify their uses.	Discuss the uses of phosphates, nitrates, carbonates, and sulfates in everyday life.
CHEMICAL EQUATIONS		
Writing and Balancing Equations	Identify the substances in a chemical reaction by reading an equation	Practice reading chemical equatio Discuss the view of Conservation o Matter

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Identify the symbols used to write chemical equations.	
	Balance simple equations.	Practice balancing simple equations.

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CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
LIVING THINGS AND NON-LIVING THINGS	Differentiate between a living thing and a non-living thing.	Study the differences between living and non-living things.
		Conduct an experiment to distinguish a living thing from a non-living thing.
	List the life activities which living things carry out.	Observe the activities of plants and animals in the classroom, school, home, petshop, zoo, etc. Record data pertaining to location, time, date organism aspects of the environment in which it lives, and activities observed.
THE CELL		
The Microscope	Name and identify the parts of the microscope.	Report on the history of the microscope.
	Label a diagram of the microscope.	Compare and contrast different types of microscopes.
	Use a miscroscope to observe simple life forms.	

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Plant and Animal Cells	Identify the differences between plant and animal cells.	Using a microscope, observe slides of both elodea and human cheek cells. Draw and label the cells.
	Diagram and label the organelles found in plant and animal cells	Construct a three dimensional model of a general plant or animal cell. Write a paragraph describing the function of each part.
	State why the cell is considered to be the unit of function and structure of all living things.	Discuss the similarities and differences between plant and animal cells.
Life Activities of Unicellular Animals and Plants	List and describe the ten life activities of unicellular animals (movement, food getting, digestion, transport, respiration, excretion, behavior, reproduction, synthesis, and growth).	Observe and compare different unicellular animal forms with regard to the way in which they carry out their life functions.
	List and describe the life activities of unicellular green plants (food making, transport, respiration, behavior synthesis, growth and reproduction).	Observe and compare different unicellular green plant forms with regard to the way in which they carry out their life functions.
		Use charts, models, films and filmstrips to study the life activities of unicellular plants and animals.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Compare and contrast the activities of unicellular green and non-green plant forms.	Observe unicellular non-green plant forms. Compare the activities to those of green plant forms.
Life Activities in Multicellular Plants and Animals	Differentiate among a cell, tissue, organ, and organ-system.	Diagram a multicellular plant and a multicellular animal to show their organization. Compare this to the organization of a unicellular organism. Study higher organisms from the plant and animal kingdom; compare and contrast how life activities are carried out.
BIOCHEMISTRY OF LIVING THINGS		
Photosynthesis	Write an equation for photosynthesis using words and chemical symbols.	Write a word equation for photosynthesis, then rewrite it using chemical symbols.
	Test green plants to show that they convert sugar to starch.	Using geraniums or other plants which have been exposed to light, test for the presence of starch. Record all procedures and observations.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Perform an experiment proving that in the presence of light green plant cells absorb carbon dioxide.	Exhale through a straw into several test tubes containing water and bromythymol blue. Add elodea leaves. Place some tubes in the light and some in darkness. Observe. Write a complete description of the experiment, including results.
Cellular Respiration	Write a word and a chemical equation for cellular respiration.	Research and report on the history of respiration. Include the contributions of: Robert Boyle, Robert Hooke and Antoine Lavoisier.
	Recall the carbon dioxide and water are produced when glucose is broken down.	Trace the production of carbon dioxide and water which occurs when energy is released from glucose, using the formula: $C_6H_{12}O_6 \quad CO_2 + H_2O + \text{energy}$
	Compare and contrast the processes of respiration and photosynthesis.	Write the following equations and compare them: $C_6H_{12}O_6 + O_2 \quad CO_2 + H_2O + \text{energy}$ and $CO_2 + H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + H_2O + O_2$ Explain why respiration and photosynthesis can be considered "opposites."

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Diffusion	Define diffusion as the movement of molecules from regions of higher concentration to regions of lower concentration.	Demonstrate the diffusion of molecules of ammonium hydroxide through a membrane using the following set up: Add 3-4 drops of alcoholic phenolphthalein to a test tube 3/4 full of water. Cover with a membrane (secured with a rubber band) and invert a test tube over the mouth of an open bottle of ammonium hydroxide. Note and explain changes that occur.
	Recall that because molecules of nutrients must pass through cell membranes, large molecules must be broken down into smaller ones.	Using a dialyzing membrane suspended in water, demonstrate the ability of small molecules of glucose to move through the membrane and the inability of large starch molecules to move through. Perform an experiment to show that saliva breaks starch down into simple sugars. Add a mixture of saliva and thin starch suspension to a dialyzing tube suspended in water; test for starch and glucose just as the experiment begins and after 20 minutes have elapsed.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
SYSTEMS OF THE BODY		
Digestive System		
Nutrients	List the major nutrients and identify several sources of each nutrient.	On a chart, list each nutrient found in food. Include its importance to the body and the foods which are good sources for each nutrient.
	Test foods for the presence of each basic nutrient.	Perform laboratory tests to detect the following nutrients: starch, glucose, fat, protein, water, vitamin C.
Digestion	Locate and name the parts of the digestive system on a chart or model. Identify the role of each organ in the system.	Label a diagram of the digestive system.
	State the importance of enzymes to the digestive process, identifying the major digestive enzymes and their functions.	Make a chart of the major digestive enzymes indicating on which nutrients they work.
	Describe the different stages of digestion by tracing the path of a piece of food through the system.	Perform experiments which illustrate the effects of ptyalin and of pepsin on food. Discuss how the action of pepsin can be increased.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Name the end products of digestion and analyze how they are transferred into the blood system.	Perform an experiment to show that saliva breaks starch down into simple sugars. Add a mixture of saliva and thin starch suspension to a dialyzing tube suspended in water; test for starch and glucose just as the experiment begins and after 20 minutes have elapsed.
Circulatory System	Use a chart or model to trace the path of blood around the body.	Dissect a frog and observe its circulatory system. Compare it to the human system.
	Identify the role of the circulatory system as it relates to breathing, nutrition and maintenance of a steady state.	List the substances transported by the circulatory system including nutrients, gases and hormones.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Use a model to trace the path of blood through the heart. Determine why the heart is referred to as a pump.	Dissect an animal heart, locate all chambers, valves, and major blood vessel connecting points.
	Identify those habits and behaviors which help us keep our hearts and circulatory system healthy.	View and discuss a film dealing with heart disease prevention.
	Devise an experiment to illustrate the effects of cigarette smoking on heart rate.	Using a student volunteer, measure pulse rate before and after smoking.
	Compare and contrast the roles of arteries, capillaries and veins.	Using a microscope, observe the circulatory system of a live goldfish.
	Deduce why blood is considered to be a tissue. Identify the components of whole blood.	Examine prepared slides of human blood. Identify red and white cells and platelets. Research the functions of each type of cell. Analyze how these cells are adapted for their special function.
	Analyze how each component is adapted to perform its function.	
	Restate the role of the circulatory system in producting and transporting antibodies.	Find out which diseases we can be protected against. Research the difference between active and passive immunity. Contrast a vaccine and a serum.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Respiratory System	Label a diagram of the respiratory system.	Use charts and models to identify the parts of respiratory system.
	Trace the path of inhaled air from its entry point around the body.	
	Use a bell jar equipped as necessary to demonstrate the mechanical process of breathing.	Set up a bell jar using Y shaped tubing, balloons and a rubber sheet to represent the parts of the respiratory system. Observe the effect of diaphram movement. Write up all observations.
	Diagram and label an air sac and capillaries. Use arrows to indicate the diffusion of gases.	
	Evaluate how cigarette smoking can affect the respiratory system.	Observe the operation of a "smoking machine" (available from the American Cancer Society.) Discuss the demonstration. View and discuss a film related to the effects of cigarette smoking.
Excretory System	Identify the parts of a kidney and the role of the kidney within the entire excretory system.	Dissect an animal kidney; draw and label the parts.
	Draw and label a nephron tubule.	Trace the exchange of urea and water between the blood and nephron tubule.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Deduce why the lungs, skin, and liver can be considered part of the excretory system.	Research the roles of the lungs, liver and skin in excretion.
Nervous System	Identify the sense organs and analyze the ways in which they interpret input.	Using three dimensional models of each sense organ, trace the transmition of impulses which allow us to see, hear, smell, feel and taste.
	Use charts and models to locate the cerebrum, cerebellum, and medulla and other parts of the nervous system. Match the parts of the nervous system with the general functions they control.	Map the areas of the brain, identifying what functions each area controls.
	Identify a neuron as the functioning unit of the nervous system.	Examine prepared slides of neurons.
	Differentiate between reflexes and complex behaviors with respect to the neural pathways traveled.	Demonstrate the knee-jerk reflex; trace a reflex arc for it. Trace the path impulses must travel in order for us to see a movie.
	Restate the functions of the cerebrum, cerebellum and medulla. Analyze how damage to these areas will affect bodily functions and behavior.	Research how blood clots or tumors may affect coordination and general functioning.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		After researching the functions of the cerebellum, describe how removal or damage will affect an animal.
	Describe how drugs such as marijuana and alcohol affect the nervous system.	Classify drugs on the basis of their effect upon the nervous system.
Muscular and Skeletal Systems	Identify bones as a support system for the body and muscles as agents of movement.	
	Recognize and classify different types of joints.	Examine a skeleton and locate different types of joints.
	Deduce the relationships between muscles, tendons, ligaments and bones.	Construct a model which demonstrates movement of a specific part of the body.
		Examine prepared slides of muscle, bone and cartilage.
GREEN PLANTS		
Requirements	Identify the conditions necessary for the growth of green plants.	Germinate seeds and care for the plants as they grow. Record data on light, temperature, water, etc.
Photosynthesis	Write a paragraph relating leaf structure to the photosynthetic process.	Observe and diagram a cross section of a leaf.
	Identify chloroplasts as the organelles responsible for carrying out photosynthesis. Write the equation for photosynthesis.	View and discuss charts, models, films or filmstrips which illustrate the process of photosynthesis.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Roots	Restate the functions of a plant's root system.	Compare the root systems of a variety of plants. Account for the differences noted.
Stems	Restate the functions and importance of a plant stem.	Observe and diagram a cross section of a plant stem.
Importance	Analyze the importance of green plants to the rest of the plant and animal kingdom. Identify the major uses of green plants in our society.	Write a fictional account of what life on earth would be like if green plants suddenly disappeared.
ASEXUAL REPRODUCTION		
Mitosis	Describe the role of the nucleus in cell division.	Observe prepared slides of onion root tip cells in division. Draw and label the difference phases which are observable.
Binary Fission	Give examples of organisms that reproduce by binary fission.	Observe and label organisms that reproduce by fission. Draw and label the stages of binary fission.
Budding	Identify organisms that reproduce by budding. Compare budding to fission with respect to the number and size of offspring.	Observe and label organisms that reproduce by budding.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES The student will be able to:	SUGGESTED ACTIVITIES
	Analyze why yeast is used in the manufacture of bread, wine and beer.	Write a short description of the fermentation process. Include the role of yeast.
Sporulation	Compare binary fission, budding and sporulation with respect to number and size of offspring and conditions necessary for growth.	Observe, draw and label slides of bread mold. Find out how to prevent or retard the growth of mold.
	Identify the useful functions of molds.	
Vegetative Propagation	Compare the methods of asexual reproduction in potatoes, grass, strawberries and tulips.	Set up demonstrations or small gardens which demonstrate the various methods of vegetative propagation.
	Recall how new coleus and bryophyllum plants can be grown without seeds.	
	Evaluate the ways in which grafting has improved the plant kingdom.	
Regeneration	Explain why cutting off the arms of a starfish will not kill it.	Experiment with regeneration in planaria; observe and describe.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Describe the similarities between animal regeneration and the way in which our bodies heal themselves after injury.	
SEXUAL REPRODUCTION IN ANIMALS		
Reproductive Systems	Trace the paths of sperm and egg thru the human reproductive system. Analyze the role of gestation in the reproductive process.	Using models and charts, label the parts of the male and female reproductive systems. Describe the function of each part.
Gametes	Identify the basic parts of the male and female reproductive systems.	
	Compare an egg and sperm cell with respect to size, number produced, motility, and life span.	Observe prepared slides of sperm and egg cells. Draw and label.
Gamete Formation	Trace the process of meiosis using charts and/or diagrams.	Using a magnetic board, paper cut-outs or similar visual material, describe the process of meiosis. Draw and label a chart showing the major events in meiosis. Chart the events of spermatogenesis and oogenesis.
	Compare meiosis to mitosis with respect to the division of chromosomes.	
	Contrast the formation of sperm and egg cells.	

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Fertilization	Define fertilization. Restate the importance of monoploid and diploid number.	Research the process of fertilization in a variety of animals. On a chart classify them as having either internal or external fertilization.
	Use charts and visual aids to trace the events occurring during cleavage, including the formation of blastula, morula, etc.	Draw labeled diagrams of cleavage.
	Identify factors which lead to twinning. Contrast identical to fraternal twins.	
Embryological Development	Identify and describe the functions of structures necessary to mammalian embryological development, e.g., placenta, umbilical cord, and amniotic sac.	Observe and compare charts depicting the embryological development of a variety of animals.
		Maintain fertilized frog eggs in spring water and chart their growth and development.
Birth	Compare the birth process in fish, reptiles, amphibians, birds and mammals.	

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
SEXUAL REPRODUCTION IN PLANTS		
Parts of a Flower	Name and locate the parts of a flower.	Dissect gladioli, tulips or other flowers. Draw and label the floral parts.
Pollination	Evaluate how various flowers are specially adapted for wind, insect, or self-pollination.	Using a microscope, observe pollen. Dissect, draw, and label those floral parts directly involved in reproduction.
	Trace the events which occur when pollen is deposited on a flower's stigma	Using a microscope, observe pollen tubes.
Seed Dispersal	Describe the relationship of a seed to a fruit. Evaluate how seeds are adapted for survival.	Bisect, draw, and label an apple.
		Dissect a lima bean. Draw and label the testa, micropyle, cotyledon, embryo, and stored food supply.
	Compare the seeds of different plants to determine how they are specially adapted for various methods of seed dispersal.	Read about the different methods of seed dispersal. Observe examples of seeds dispersed by each method.
Germination	Identify the conditions necessary for seed germination.	Set up experiments which allow comparisons of different physical conditions and how they affect seed germination. Compile data and discuss.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
ECOLOGY		
	Identify the components of a selected community or ecosystem, then identify what each component contributes to the system.	After determining the necessary components of a "balanced" aquarium, set up and maintain one as an example of a closed ecosystem.
Food Webs	Diagram a food web and identify the consumers, producers, and decomposers. Explain why a green plant is always the first link. Identify the contribution of each member to the survival of the entire web.	Define the roles of consumers, producers and decomposers in a food web. Observe and analyze diagrams of food webs.
	Classify consumers as herbivores, carnivores, or omnivores based upon their diet.	Define herbivore, carnivore, and omnivore. Give examples of each.
Symbiosis	Define symbiosis. Categorize symbiotic relationships on the basis of benefits derived.	Read descriptions of the relationships between the following pairs of organisms: shark-remora fish; termites-intestinal protozoans; dog-tick. Classify them according to the type of symbiotic relationship displayed.
	Give examples of symbiotic relationships and classify them as mutualism, commensalism or parasitism.	
	Analyze the advantages and/or disadvantages of each type of symbiotic relationship.	Show and discuss films or filmstrips which deal with symbiosis.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Biomes	Name the biomes of the world and locate them on a map.	Using a map of the world, locate the different biomes.
	Identify the special adaptations of plants and animals which aid their survival in the different biomes on earth.	Research the characteristics of the following biomes: desert, tundra, tiaga, temperate deciduous, forest, grasslands, and tropical rain forest. Identify some of the most common forms of life, noting their special adaptations for survival.
		Using a terrarium, create and maintain a desert or temperate biome.
Pollution	Identify pollutants as substances that interfere with the balance of nature.	Study a diagram of the water cycle. Describe how chemical wastes, large amounts of heated water or disease- causing organisms may interfere with the cycle. How does this affect the balance in an ecosystem?
	Identify the major sources of air, water and land pollution.	Study a diagram of the carbon and oxygen cycles. Determine how pesticides, vehicular exhaust fumes and factory wastes interfere with the cycle. How does this affect the balance in an ecosystem?
	Suggest ways in which various sources of pollution can be controlled.	Research and report on legal measures and technological advances aimed at curbing pollution.

High School Physics

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
MEASUREMENT	Measure lengths, weights, and volumes in both English and Metric units.	Make length measurements with rulers, meter sticks, and tape measures in both English and Metric units. Measure weights with spring or beam balances. Measure volumes with graduated cylinders.
MOTION		
Speed, Velocity, and Acceleration	Determine the speed of an object moving slowly at a constant velocity.	Make distance and time measurements using a meter stick and clock. Calculate the speed using the formula $v = s/t$.
	Construct and interpret speed vs. time graphs of constant velocity. Observe the slopes of a line graphs to compare speeds.	Gather data in the laboratory and construct graphs based on the data. Slow constant velocity can be measured by pulling a block with a string wound about the shaft of a slow speed motor or phonograph turntable.
	Determine the acceleration of an object slowly accelerating from rest.	Measure the distance and time for a cart pulled along a table top. The cart may be pulled by a small weight hanging over the edge of the table. Calculate acceleration using the formula $a = 2s/t^2$.
122	Construct and interpret speed vs. time graphs of accelerated motion. Changes in velocity shall be determined qualitatively by changes in the slope of the graph line.	Make graphs of data gathered in the laboratory. Complete worksheets prepared by teacher to show acceleration data of everyday objects such as automobiles, airplanes, and rockets. 123

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Newton's Laws of Motion	Find the qualitative relationships between the mass of an object and the relative difficulty encountered in making its speed change.	Apply a constant force to objects having different masses. Graph the data of force vs. mass to show that a straight line relationship exists.
	Determine the relationship between the acceleration of an object and applied forces.	Apply different forces to a laboratory cart. Measure the acceleration with the aid of a meter stick and timer.
	Design a laboratory experiment to demonstrate conservation of momentum in an explosion.	Spring two laboratory carts apart using a flat or coiled spring between them; stop the carts using a string connecting them. Relate the distances travelled to the masses of the carts.
POTENTIAL AND KINETIC ENERGY	Define potential and kinetic energy.	Swing a simple pendulum to observe the qualitative relationship between the initial height of the pendulum bob and speed at the bottom of the swing. Observe the reduced height of the bob after each swing due to frictional losses.
	Explain how potential energy is converted to kinetic energy and how kinetic energy is converted to potential energy. Demonstrate that there is no energy gain during such an exchange but only losses due to frictional heating.	

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
LIGHT		
Reflection	Establish the position and size of the virtual image formed by a plane mirror.	Locate the corners of an image formed behind a mirror using the process of triangulation.
	Verify that the angle of incidence is always equal to the angle of reflection.	Use a narrow light beam or laser beam and protractor to measure the angles formed by light rays and the normal to a mirror surface.
Refraction	Draw ray diagrams showing the path of light rays as they traverse air-glass or air-water interfaces.	Use blackboard optics to illustrate refraction. Sight a row of straight pins through rectangular and triangular glass prisms.
		Observe an intense light beam change direction as it enters a tank of water into which a few drops of homogenized milk have been added.
	Draw ray diagrams showing light-rays being converged or diverged by lenses.	Observe demonstrations of light rays being bent by lenses. Use parallel beams of light and converging and diverging lenses of different focal lengths to demonstration refraction.
	Predict the location, relative size, and attitude of real images formed by converging lenses, given the object size and distance and the focal len of the lens.	Practice solving simple optical problems using the lensmakers formula $1/f = 1/p + 1/q$

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		Using paper screens, form images of illuminated objects which are placed at various distances from the lens.
Speed of Light	Describe two methods for measuring the speed of light using appropriately labeled diagrams.	Read a description of Roemer's method for calculating the speed of light. Also read about Michelson's technique of using fixed and rotating mirrors.
Characteristics of Light Waves	Account for the difference in the intensity between coherent and non-coherent light.	Demonstrate differences in the intensity of ordinary light sources and that of a low-powered laser.
		Show mechanical examples of constructive and destructive interference using swinging pendulums or small masses bouncing at the ends of coiled springs.
	Identify the family of electromagnetic radiations of the electromagnetic spectrum.	Observe charts which show the major types of electromagnetic radiation as a function of the wavelength. List the types of radio waves, visible and invisible light waves, and penetrating radiations in order of the wavelength or the frequency of the associated electromagnetic wave.
	Explain the polarization effects of light using simple mechanical analogies.	Observe a "venetian blind" polarization analogy model. Observe light passing through two sheets of polaroid film as one of the sheets is rotated.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		Test the ability of polaroid sunglasses to absorb glare as the sunglasses are rotated.
ELECTROMAGNETS	Predict the direction of the magnetic field at any point surrounding a current carrying conductor.	Practice using the left hand rule for predicting the direction of magnetic fields.
	List the factors which affect the intensity of the magnetic field near a coil of wire carrying an electric current.	Examine the effects of current magnitude, number of turns of wire in the coil, permeability of the core, and geometry of the coil on the intensity of magnetic fields.
ELECTRIC MOTORS	Identify the working parts of a simple dc motor and describe the scientific principles of each part.	Observe a demonstration of a St. Louis motor. Make a simple motor using inexpensive kits of wires and nails.
SOUND	Measure the time required for sound to travel a known distance.	With a large wall or other reflecting surface a known distance away, operate a pair of clap boards to overlap the original sound and echo.
	Differentiate between wavelength, frequency, and amplitude.	Illustrate pulse transmission of a compressional wave using a long coiled spring.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Relate the length, diameter, and tension of vibrating springs and the frequencies of sounds generated.	Use a sonometer to vary the length, diameter, and tension of a vibrating string while listening for differences in pitch. Measure the intensity of various sounds using a portable decibel meter.
HEAT		
Temperature Scales	Convert Fahrenheit scale readings into Celsius readings and Celsius to Fahrenheit.	Calibrate a blank mercury or alcohol thermometer using ice water and boiling water for the fixed points. Keep a log of classroom temperatures in both Fahrenheit and Celsius readings.
Calorimetry	Compute the specific heat of a metal using the principle of mixtures.	Find the specific heat of a metal by placing a known mass of hot metal into a styrofoam or other calorimeter full of cold water.
Heat Transfer	Distinguish among the three methods of heat transfer (conduction, convection, and radiation).	Learn to use a conductometer, convection box or liquid convection apparatus, and radiometer.
Heat Expansion	Measure the coefficient of linear expansion for one or more common solids.	Measure the coefficient of linear expansion of aluminum, brass, iron, glass, or other material. Use a solid rod of the

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		material at least 50 cm long, and home made or commercial apparatus.
ELECTRICITY		
Electrostatics	Predict the attraction or repulsion between two charged objects.	Observe attractive and repulsive forces between charged objects such as rubber, glass and lucidity. Use an electroscope to determine the relative magnitude of forces emitted by charged objects.
Conductors and Insulators	List a variety of common materials in ascending order according to their ability to conduct electricity.	Find the relative ability of materials such as metals, wood, rubber, and plastics to conduct electricity. Use a light bulb or an electric meter in series to determine the degree electron of flow.
Ohm's Law	Calculate the resistance, voltage, and current in a simple electric circuit using the equation V=IR.	Measure the resistance of common objects such as copper, aluminum, or nichrome wire. Use lengths that are sufficient to have a resistance of several ohms. Applied dc voltages may be measured with a suitable voltmeter and currents with an ammeter.
Series Circuits	Connect at least two circuit elements in series with a source of EMF and predict the current and the voltage drop across each circuit element.	Observe a demonstration of a large circuit board with three or four 25W bulbs connected in series.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Parallel Circuits	Connect two or more circuit elements in parallel and predict the current and the voltage drop across each element.	Observe a large circuit board with three or four 25 W bulbs connected in parallel. Experiment with bulbs and batteries to form series and parallel circuits. Predict the effects on bulb brightness as additional bulbs and batteries are added.
Electrical Power and Heating	Calculate the amount of electrical energy that is consumed by various home appliances given the power rating in watts and the time of operation.	Calculate the cost of operating home appliances such as televisions, electric shavers, and lights. Measure the heat produced by operating an immersion heater in water for several minutes. Compare the cost of operating an electric incandescent bulb and a florescent lamp of equal intensity.
MAGNETS	Sketch the pattern of the magnetic field surrounding a bar magnet. Predict magnetic attraction or repulsion between magnets and magnetic materials in magnetic fields.	Sprinkle iron filings over a sheet of paper beneath which a bar magnet is held. Suspend bar magnets in the magnetic field of the earth and observe responses. Test various materials for magnetic effects using a strong alnico magnet.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Make a magnet from a bar of unmagnetized iron. Restate the domain theory of magnetism.	Magnetize a bar of iron or steel by induction. A strong alnico magnet should be stroked along the length of the bar in one direction.
ATOMIC RADIATION	Predict the effect of a magnetic field on the paths of radioactive particles.	Practice hand rules to predict the direction of force on a charged particle moving through a magnetic field. Observe how the trails left by alpha and beta particles in a cloud chamber are deflected as the direction of the magnetic field is varied.
Particle Detection	Explain how at least two detectors of atomic radiation operate.	Observe methods of gathering data on radiation using photographic film, electroscopes, and Geiger counter reactions.
Atomic Transmutation	Balance simple atomic equations involving alpha and beta emissions from a radioactive element.	Practice balancing equations so that both charge and mass are conserved as particles are emitted and atomic numbers change.
Half Life	Measure the half life of a short lived radioactive element.	Use a nuclear scaler or ratemeter to measure the half life of a short lived radioisotope. Determine half life using an analogy apparatus containing beans, coins, or similar materials which can "die" at appropriate rates.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Atomic Fission	Draw and label a diagram illustrating the atomic fission of a heavy element into lighter elements and free neutrons.	Review atomic equations. View overhead transparancies which illustrate the process of atomic fission. Visit a nuclear power plant and examine models of the nuclear generators. View films distributed by the Department of Energy.
Atomic Fusion	List the advantages and disadvantages of obtaining energy atomic fusion.	View and discuss movies of atomic fusion reactions. Invite outside speakers to discuss the practical aspects of atomic fusion.
Elementary Paricles	Identify at least 5 elementary particles in addition to the electron and proton and cito the major identifying charactoristics of each.	Discuss the discoveries of neutrons, neutrinos, anti-particles and muons. Gather information on the current search for truly elementary particles such as quarks.

High School Earth Science

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CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
MINERALS		
Properties	Identify at least four common rock-forming minerals by their physical and chemical properties.	Perform a visual observation to determine color, luster and transparency of mineral samples.
	Recognize cubic, rhombohedral, and hexagonal crystals in minerals.	Inspect cubic crystals of salt or galena, rhombohedral crystals of calcite, and hexagonal crystals of quartz.
	Perform tests of hardness.	Test mineral specimens for hardness using Mohs' mineral scratch kit or test with fingernails, copper pennies, and steel knives.
	Cleave minerals along natural cleavage planes.	Use a razor blade to split mica into thin sheets, calcite into rhombohedrals, and feldspar to demonstrate right angle cleavage.
	Distinguish between cleavage and fracture.	Observe samples of quartz or obsidian showing conchodal fracture.
	Perform streak tests.	Test minerals for streak by rubbing against an unglazed porcelain plate and observing color of marks that remain on the porcelain.
	Measure the specific gravity of mineral samples.	Measure the weight and volume of a sample. Calculate the specific gravity.
	Perform acid tests.	Pour cold dilute hydrochloric acid on calcite and look for bubble reacti

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
ROCKS		
Origin	Trace the origin of the three major types of rocks.	Simulate the formation of igneous rocks by cooling a hot liquid to form a solid. Mix sand, clay and pebbles in a tall jar of water and allow particles to settle to show stratification. Squeeze bakelite particles in a hot hydraulic press and examine the product for changes in its physical properties.
Classification	Classify rock specimens into major types and identify those rocks which are relatively easy to find and name.	Collect samples of local rocks. Examine samples of better known igneous, sedimentary, and metamorphic rocks. Visit buildings and identify rocks used in their construction.
WEATHERING		
Physical Weathering	Recognize evidences of physical weathering.	Break a rock by filling a crevice with water and freezing it. Search the local area for sidewalks and rocks that have been cracked by plant roots.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		Observe and account for changes found in tombstones, monuments, marble steps, flagstone walks and brownstone houses.
Chemical Weathering	Distinguish between physical and chemical weathering.	Observe rocks that have undergone chemical weathering. Record the changes that have occurred.
		Pour dilute hydrochloric acid on marble chips or chalk. Bubble the evolved carbon dioxide gas through limewater to form a calcuim carbonate precipitate.
SOILS		
Classification	Classify soils by their physical characteristics and origin.	Discuss the relationship between humid climate, plants, and humus in the soil.
	Compare deep residual soils and relatively unweathered recent glacial deposits.	Discuss how various types of transported soils may be recognized. Identify residual soil samples. Tell what agent may have carried the transported soil samples.
		Check for the presence of soil bacteria and plant and animal products in soils closest to the surface.
Conservation	Suggest conservation practices that will preserve soil for future generations.	Use films and booklets supplied by the United States Department of Agriculture Soil Conservation Service to show the value of soil conservation and flo control.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		Investigate methods of protecting the sides of parkways from soil erosion.
GROUND WATER	Correlate the operation of wells with changes in the underground water table.	Draw labelled diagrams of temporary, permanent and artesian wells showing the associated wet and dry water tables for each.
		Construct and demonstrate a working model of an artesian well.
	Explain how natural features such as swamps, lakes, springs, and geysers are affected by surface topography and underground configurations.	Build a working model of a geyser using a funnel connected to a florence flask by rubber tubing, and a source to heat water in the flask. Compare its action to a coffee perculator.
		Study pictures of working geysers and watch home or commercial movies showing geysers in operation.
		Study topographic maps in which springs, swamps and lakes are shown. Note their alignment and location in relation to the elevation and slope of the surface. Also note the sudden appearance and disappearance of streams fed by underground sources.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
MAP READING	Demonstrate proficiency in reading and interpreting topographic maps.	Memorize typical conventional map symbols such as schools, railroads, houses, churches, highways, lakes, rivers, swamps and bench marks.
		Locate points on a topographic map given latitude and longitude.
		Determine elevations of points on a map using contours and bench marks.
	Relate the symbols, colors, and measurements on a topographic map to the corresponding features found on the earth.	Plan a detailed geographic field trip with the aid of a topographic map and identify key topographic features.
		Draw reasonably accurate topographic maps of the local area based on measurements of distances and elevations obtained in the field.
	Predict the direction of magnetic north by reading the arrows and changes in annual magnetic declination found on a map.	
EROSION		
Erosion by Running Water	Recognize the evidences of erosion caused by running water in the local area.	After a rain, observe gullying in open lots, parks, earthen banks, edges of excavations, sand piles.

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CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		Examine aerial photographs and models showing networks of valleys. Point out the locations streams, divides and slopes.
		Discuss how the effects of irregular wear cause potholes, waterfalls, rapids, water gaps, wind gaps and narrows.
	Identify the life stage of a river or stream by its volume, velocity, and erosional features.	Experiment with model streams in a sand box or stream table.
	Cite the geologic history and developments that gave rise to features such as alluvial fans, waterfalls, deltas, levees, V shape valleys, meanders, rounded pebbles and boulders, oxbow lakes and gorges.	Complete teacher prepared worksheets which require listing the characteristics of young, mature and old stages in the stream life cycle.
		Take field trips to local rivers, such as the Bronx River, which illustrate many of the typical patterns and erosional features of streams.
	Recognize the dangers of camping in dry river beds and river flood plains which are likely to become flooded as the weather changes.	Study topographic maps of regions containing rivers in the young, mature and old stages of their life cycles.
		Watch films of rivers eroding the land, flooding, and depositing stratified sediments.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Erosion by Glaciers	Find and recognize local evidences of Pleistocene glaciation. Describe the geologic history of glacial features that are encountered.	Field trips to Inwood park in Manhattan and the terminal moraine which runs across Brooklyn, Queens and Long Island to examine the erosional and depositional remnants of the last glacier which include: kames and kettle holes, kettle lakes, ground moraine, outwash plain, potholes and striae.
	Compare Alpine and Continental glaciation.	
	Identify characteristic glacial features which include snowfield, snowline, crevasses, etc.	View and discuss films which depict the origins and movements of valley glaciers.
		Recount the story of the drowning of the mouth of the Hudson River after the glacier changed its shape from a "V" to a "U".
	Present scientific reasons which account for previous periods of glaciation and predict the coming of new periods of glacial formation.	Use maps of North America which show the centers of accumulation of the previous glaciers and their movements which formed the Great Lakes and deepened Finger Lakes.
		Collect samples of rocks which are found locally and have been transported great distances by glaciers.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
OCEANS	Name and locate the major oceans of the earth.	Use a globe or map of the earth to locate the oceans in relation to the nearby continents.
	Describe the causes of ocean waves and the potential for utilizing ocean wave movements as a future source of energy.	Generate waves in a ripple tank and measure the wave period, frequency, speed in shallow and deep waters, and wave height.
		Discuss the effects of the wind which generates waves and imparts energy as a function of wind speed, duration, and fetch.
		Design devices that can utilize the energy of ocean waves to run a machine or generate electricity.
	Plan a scientific experiment to explore the ocean for salinity variations, locations of thermoclines, undersea life, and movements of surface and undersea ocean currents.	Examine oceanographic apparatus for measuring temperature, pressure, salinity and fluid velocity. Examine apparatus for obtaining sea bottom cores and samples of underwater life.
Currents	Account for the movements of ocean currents and state the factors that cause and shape these ocean currents.	

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CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Name and locate some of the major ocean currents of the world and tell how each affects climate or economy on the land masses that are touched.	Refer to standard maps showing the ocean currents of the world. Notice the directions of circulation due to coriolis effects. Refer to encyclopedia and report on the influences of cold and warm ocean currents on the continents that are touched by the water.
Crustal Change	Cite evidences of deep crustal change such as the growth of undersea ridges, mountain ranges, trenches and the sinking of portions of continents.	Evaluate evidences of ocean floor spreading which include similarity of rocks and minerals found on matching continental margins, matching mountain formations in different continents, the fossil records, climate records, and reversals of magnetic fields in rock layers.
INTERIOR OF EARTH	Locate, on a simple diagram, layers of the earth's interior and describe the physical characteristics of each layer.	Using a worksheet, label the inner core, outer core, mantle, and crust. Report on project "Moho," the effort to reach the boundary between the earth's crust and mantle.
	Draw and interpret graphs showing how the earths' temperature and density change with increasing depth below the surface.	Discuss the practical reasons for difficulties encountered in attempting to drill more than a few miles below the earth's surface.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		Make scale models of the earth's interior with labels to indicate distances, temperatures, and densities of respective layers.
EARTHQUAKES	Trace the events leading to an earthquake.	Review movements of the large crustal plates that build up pressures at the major earthquake and volcanic zones of the world.
	Differentiate between L, P and S earthquake waves according to amplitude, directions of oscillation, speed, and sequence.	Study seismographic records of major earthquakes. Visit a seismographic recording station.
	Locate the epicenter of an earthquake given relevent seismographic data from distant stations.	Use a compass and ruler to triangulate and find the epicenter of an earthquake on teacher prepared outline maps.
		Build and operate working models of seismographs.
		Build and test models of "earthquake proof" buildings.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
SHORELINES	Recount the origin of shorelines. Recognize geologic features associated with these shorelines on topographic mapes, and predict inevitable changes that will occur in the near and distant future.	Use models and diagrams to demonstrate the formation of shorelines. Partly submerge large models of an irregular landmass in a fishtank filled with water. Notice the islands, peninsulas and bays that are produced. On teacher prepared diagrams, identify features associated with coastlines such as promontories, estuaries, seacliffs, offshore and baymouth bars, and lagoons. Study topographic maps of the New England and Carolina coasts for evidences of uplift or sinking. Visit local beaches and observe daily evidences of shoreline erosion.
DATING GEOLOGIC EVENTS	Apply the principles of uniformitarianism and superposition to the dating of geologic events. Compare geologic columns noting the arrangements of rock layers index fossils.	Use teacher prepared worksheets and diagrams as well as photographs of major index fossils to aid in piecing together sequences of past events. Examine models of geologic columns.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Identify the major plant and animal life existing during each of the geologic eras and periods of earth history.	
	Infer the geologic history of an area by examining exposed rocks and soils.	Take field trip to appropriate locations which can provide evidences of the earth's past. Identify fossils that are found with the aid of library reference books. Exchange fossils with students of other localities.
	Calculate the approximate age of a geologic feature which contains a known radioactive element together with its decay products.	Measure the radioactive activity of a short-lived radioisotope such as barium (Ba 137m) indium (In 113m) or radioactive phosphorus with a nuclear scaler or geiger counter.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
THE UNIVERSE		
Planets	List the planets in order form the sun. Identify planets based upon physical charactoristics and features.	Study charts and monographs prepared by scientific agencios.
Galaxies	Draw a diagram of the Milky Way galaxy and locate the relative position of our sun. Identify at least one other galaxy in the sky beyond the Milky Way.	View the Milky Way as drawing in a star chart. Observe the Milky Way and other galaxies by looking at the sky on a clear night.
Constellations	Identify at least 10 of the major constellations that are visible in the norther hemisphere. Use a star map to predict the constellations that will become visible during the diffe.ent months of the year.	Practice reading star maps, adjusting the orientation of the map to correspond with the date and time of observation. Observe the constellations on clear nights. Write report on the significance and history of the constellation names.
Telescopes	Differentiate between reflecting and refracting teleschopes and list the major advantages and disadvantages of each.	Construct a simple reflecting and refracting telescopes in the lab by aligning converging lenses and mirrors on a meter stick.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Calculate the increase in light gathering power and resolution of a telescope as the area of the objective lens or mirror is enlarged.	Form an image of the sun on a piece of cardboard using one or more converging lenses. Take pictures through a telescope of a astronomical and terrestrial objects.
Spectra	Explain how bright line and dark line spectra are formed and interpreted.	Produce continuous spectra by passing a beam of white light through a triangular glass prism or an inexpensive diffraction grating. Observe the simple spectrum formed when sodium light is viewed through a spectroscope.
	Correlate the changes in a spectrum that are associated with a star approaching or receding from the earth.	Examine a photograph showing a doppler shift spectrum.
Stars		
Star color	Relate star color to the surface temperature of the star.	Heat iron in a darkened room and observe, color changes as the iron temperature increases.
Star origin and demise	Retell the sequence of events that give rise to the birth of a star.	Study the life history of a star. Arrange a set of star photographs into a logical sequence of star life chronology and identify the key stages.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Motions in space	Chart the movements of the planets, stars, meteors, and comets over a period of one month.	Watch motion pictures of astronomical objects in motion. Chart the positions of visible planets over a period of a month or two.
The Moon		
Moon topography	Identify some of the prominent features of the moon.	Examine photographs, watch filmstrips and slide shows, and observe the moon on a clear night through a telescope.
Moon motions	Draw labelled diagrams showing the moon's rotation, revolution around the earth, and path of its orbit around the sun.	Replicate motions of the moon using spheres or commercial models to represent the sun, earth and the moon.
Moon phases	Name the phases of the moon in sequence starting with new moon and ending with old crescent. Draw diagrams showing the relative positions of the sun, earth, and moon during each of the phases.	Arrange models which demonstrate that the moon appears differently depending upon the position of the earth.
Eclipses	Draw labelled diagrams of the sun, earth, and moon at times of solar and at lunar eclipses.	Perform a lab exercise to create model eclipses using spheres and source of illumination.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Account for the differences in shadow between the umbra and penumbra.	
	Explain why solar eclipses are not as common as lunar eclipses.	
Tides	Predict the times of high and low tides given a particular location, time, and the present tide at that location.	Study models of direct and indirect tidal bulges at high tide.
	Account for the differences in tidal range at different phases of the moon.	Report Newton's Laws of gravitational attraction.
Latitude and Longitude	State the latitude of his or her present location as well as the latitudes of key locations on the earth such as the equator, tropics, poles, and arctic circle.	Draw lines representing degrees of latitude on an opaque or transparent globe.
	Calculate differences in latitude between any two given locations on the earth.	Perform exercises to calculate differences in latitude in degrees, minutes, and seconds.
	Correlate differences in latitude with distances in statute miles between two locations having the same longitude.	Locate points on a globe or topographic map given latitude and longitude data.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Identify climatic conditions associated with different latitudes.	
	State the longitude of his or her present location as well as the longitude of key locations on the earth such as the prime meridian and the international date line.	Draw lines representing degrees of longitude on a globe or map.
	Calculate the differences between two given locations on the earth.	Practice calculating differences in longitude.
	Explain why it is difficult to correlate differences in longitude with distances in statute miles.	
Rotation of the Earth	Draw diagrams which illustrate why the earth has day and night and why the length of the daylight hours changes during the year.	In a darkened room set up spheres to represent the sun and earth. Illuminate the sun and observe as the earth rotates.
		Observe a Foucault pendulum or pendulum model to verify that the earth rotates about its axis in 24 hours.
	State the time at any location on the earth given the longitude and the correct time at the prime meridian.	Draw lines to represent meridians on worksheets or globes and indicate the time at each meridian, subtracting an hour for each 15 degrees west or adding an hour for each 15 degrees east.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
		Observe a spinning globe of the earth from a fixed location representing the position of the sun.
	State the purpose of the international date line and the changes that occur when it is crossed.	
Revolution of the Earth	State Kepler's first and second laws of planetary motion and explain why the earth moves faster when it is closer to the sun.	Draw ellipses, using pencil, thumb tacks and string, to represent the earth's orbit around the sun. Divide an ellipse into two sectors of equal area and measure the arc of each sector.
	Draw diagrams showing the position of the earth at each of the seasons, solstices and equinoxes. Explain why it is summer in the northern hemisphere when the earth is furthest from the sun.	Use a photometer to measure the differences in light intensity on surfaces normal to light rays and surfaces tilted at angles up to 90 degrees from the normal.
METEOROLOGY		
Atmosphere	Identify the various layers of the atmosphere by altitude.	Fill in teacher prepared outline charts showing the locations of troposphere, stratosphere, mesosphere, and ionosphere with the tropopause, stratopause, and mesopause correctly located.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Greenhouse Effect	Explain how the atmosphere traps heat energy from the sun.	Build a model greenhouse and measure temperature differences outside and inside while the greenhouse is illuminated by real or artificial sunlight.
Atmospheric Heat Transfer	Differentiate among conduction, convection, and radiation as processes of heat transfer.	Watch demonstrations of conductometers, convection boxes, and vane radiometers.
	State the relationship between altitude and temperature.	Construct a graph which illustrates the relationship of altitude to temperature.
Temperature Measurements	Measure temperatures using liquid thermometers. Construct and interpret thermocline maps.	Measure classroom temperature at different locations in the room and construct a series of isotherms on a teacher-prepared worksheet.
		Study isothermal charts of the world at different seasons of the year.
Atmospheric Pressure and Winds	Read a mercury and an aneroid barometer and explain the principles of operation of each.	Watch a demonstration of a barometer made by inverting a long tube of mercury into a dish of mercury.
	Convert barometric readings from inches of mercury to millimeters, millibars, torrs, and pascals.	Construct an aneroid barometer from scrap parts and demonstrate its action in a closed bell jar as the pressure in the jar is changed.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Correlate changes in air pressure with altitude.	Practice reading unit conversion tables found in textbooks.
		Measure the height of your school building by finding pressure differences between the entrance and roof.
	Identify the variations in air pressure caused by moist vs. dry air and between rising and descending vertical air currents.	Keep records of air pressure and correlate them with weather observations.
	Interpret weather maps having isobars in order to predict wind direction at various locations.	Analyze a series of U.S. Weather Bureau weather maps to see how winds always blow from high to low pressure areas.
	Read weather map arrows and identify the wind speed and direction at weather stations.	Practice reading Beaufort scale charts and weather bureau symbols. Record local wind directions and speeds using a weather vane and annemometer.
Atmospheric Circulation	Draw a diagram of the earth's principal pressure belts and indicate the directions of the prevailing winds between each pair of pressure belts.	Complete a generalized map of the pressure and wind belts of the earth from a teacher-prepared outline map of the earth.
	Name the earth's prevailing winds based on the direction of their origin.	Label each of the earth's prevailing winds correctly on the generalized map.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
	Differentiate among and state the principle causes of land and sea breezes, mountain and valley breezes, monsoons, tornados, and hurricanes.	Measure the differential heating of water, light and dark colored soils, and smooth and rough surfaces. Repeat convection box demonstrations to observe the horizontal air movements near the surface.
Precipitation	State the relationship between cloud formation and increases in the relative humidity of the atmosphere.	Observe cloud formation in a flask containing water, water vapor and smoke particles as the air pressure is suddenly decreased.
	Deduce the necessity for having condensation nuclei such as dust before it can rain or snow.	Measure humidity using hygrometers or wet and dry bulb thermometers.
	Differentiate among the terms fog, clouds, absolute humidity, relative humidity, snow, sleet, hail, and dew point.	Observe changes in temporature that occur as air is subjected to increases of pressure.
Clouds	Name the 10 principal types of clouds and classify them according to altitude and weather changes they produce.	Study photographs of clouds. Identify clouds observed from the classroom window.
	Read and interpret cloud symbols on weather maps.	Identify cloud types on a U.S. weather map.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Weather Maps	Interpret the symbols on a weather map. Describe the weather in a given area based on a weather map of that area.	Read the weather symbols on U.S. weather maps. Interpret the data to identify wind direction and speed, cloud cover, ceiling visibility, air pressure, temperature, relative humidity and local precipitation. Fill in symbolic data on a teacher prepared worksheet with actual or assumed weather data.
Air Masses and Fronts	Classify air masses based on tropical or polar origin, continental or maritime features, and their relationship to the surface over which the air mass is travelling.	Study charts which identify the names, abbreviations and characteristics of the principal types of air masses.
	Define cold fronts, warm fronts, and stationary fronts. Recognize the symbols for these fronts on a weather map. List the sequence of weather changes that accompany each type of fronts.	Make cross sectional diagrams of cold and warm fronts and indicate the types of clouds that accompany these fronts. Examine a current weather map and predict the changes that are likely to occur as fronts approach and pass a location.
Climate	List the major types of climate on the earth and the factors that are responsible for each.	Review the effects of latitude, altitude, distance from large bodies of water, topographic features prevailing winds, and ocean currents on climate.

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CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
LABORATORY WORK		
Safety	List safety rules related to working in the laboratory.	Observe a demonstration of the proper use of Bunsen burners and other laboratory equipment.
Measurement	Measure lengths, weights, and volumes in both English and Metric units.	Make length measurements with rulers, meter sticks, and tape measures in both English and Metric units. Measure weights with spring or beam balances. Measure volumes with graduated cylinders.
MATTER		
Classes of Matter	Identify the three classes of matter (element, compound and mixture) and differentiate among them.	List twelve household substances. Classify them as elements, compounds or mixtures.
Phases of Matter	Classify substances according to their phase (solid, liquid or gas).	Observe examples of each phase of matter. List the physical properties that distinguish each phase. Measure each substance using meter sticks, graduated cylinders, and other necessary devices.
	Enumerate the physical properties of each of the three phases of matter.	
	Define and calculate the density of an object.	Calculate the density of several objects using the formula D=M/V.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Changes of Phase	Identify the conditions which cause changes of phase. Use graphs to determine the effect of temperature change on phase.	Define boiling, freezing and melting point; evaporation; condensation; and sublimation.
	Demonstrate that a change of phase is accompanied by the absorption or release of heat.	Design an experiment to illustrate how water can be changed from a liquid to solid to gas.
	Describe the relationship of temperature and pressure to volume changes in gases.	Observe the operation of a barometer. Observe the effect of warming by noting the result of placing one's hands around the bulb of an air thermometer.
CLASSES OF MATTER		
Elements		
Metals and non-metals	Differentiate between metals and non-metals based upon their physical properties.	Demonstrate how metals display ductility, malleability, electrical conductivity, head conductivity and luster.
Compounds	Recall that a compound is composed of elements.	Observe the formation of a compound from its elements and the decomposition of a compound into its elements. Discuss the physical and chemical characteristics of compounds such as state, odor, color, solubility, etc.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Acids	Use laboratory tests to identify an acid.	Name some common acids and identify their uses. Perform laboratory experiments on selected substances to test their acidity.
Bases	Use laboratory tests to identify a base.	Name some common bases. Peform laboratory experiments to determine if selected substances are bases.
Organic Compounds	Select organic compounds from a list of chemical formulae. Differentiate between an organic and inorganic compound.	Define organic compound. Reseach the characteristics of an organic compound.
Mixtures		
Suspensions and Solutions	Compare the properties of suspensions and solutions including particle size, Tyndall effect and rate of settling.	Prepare a suspension of sand and water and a solution of salt and water. Observe and record the following: a) the effect of a beam of light passing through each b) the result after they are left standing c) the effect of filtration.
	Differentiate between a solute and solvent. Predict the solubility of a solute based upon temperature.	Prepare solutions of salt and water at different temperatures. Draw a solubility curve.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Colloids	Differentiate a colloid from a suspension or solution. Evalute how Brownian movement and the Tyndall effect are related to the properties of a colloid.	Pass a light beam through a colloid and observe the results.
ATOMIC STRUCTURE		
Atomic Theory	Restate the principles of the modern atomic theory.	Report on the historical development of the modern atomic theory.
Composition of the Atom	Draw and label a general model of an atom. Calculate mass numbers given proton and neutron numbers. Derive neutron numbers given mass and atomic numbers.	Practice reading the periodic table to determine electron and proton number. Practice calculating atomic mass.
Isotopes	Differentiate between an element and an isotope.	Research the uses of radioactive isotopes.
Bohr Model	Draw Bohr diagrams of simple elements of the periodic table. Label each shell and identify the valence shell of each atom.	Draw Bohr diagrams of the first twenty elements.
	Recognize that each element has a different bright line spectrum which can be identified with a spectroscope.	Discuss the relationship of energy levels to the Bohr model. Observe the flare spectra of various elements.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
THE CHEMICAL BOND		
Bonding	Determine the valence of an element by reading the periodic table.	Discuss why the chemical behavior of an element depends upon the composition and completeness of the valence shell.
Ionic Bonding	Predict how an atom with an incomplete valence shell will gain stability. Demonstrate electron transfer using Lewis dot diagrams. Define an ion as an atom that has acquired an electrical charge as a result of gaining or losing electrons.	Using a felt or magnetic board, demonstrate atoms accepting and donating electrons during a chemical reaction. Repeat using Lewis dot diagrams. Learn how to determine valence numbers using the periodic table.
Covalent Bonding	Distinguish covalent from ionic bonding.	Depict covalent bonding using Lewis dot diagrams.
THE PERIODIC TABLE	Read and interpret the periodic table.	Practice reading the periodic table. Fill in a teacher prepared worksheet to practice gathering data from the table.
	Differentiate among families of elements.	Compare the properties of the different families of elements.

CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
FORMULAS AND EQUATIONS		
Formulas	Recognize and write the symbols for twenty common elements.	Complete a worksheet of the first twenty elements.
	Write for formulas for simple compounds from the names of the compounds	Using worksheets, practice writing formulas for simple compounds including those containing ionic radicals.
Equations	Write and balance simple equations for the following types of reactions: synthesis, decomposition, simple replacement, and double replacement.	Practice balancing simple chemical equations.
ORGANIC CHEMISTRY		
Properties	Differentiate between an organic and inorganic compound and recall the general properties of organic compounds.	From a list of compounds select those that are organic. Define the properties of organic compounds.
Structural Formulas	Write the structural formulas for simple organic compounds.	Practice writing structural formulas for simple compounds and their isomers.
Isomers	For a given organic compound, draw the structural formulas for that compound and one or two of its isomers.	

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CONTENT AREA AND TOPIC	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES
	The student will be able to:	
Saturated and Unsaturated Compounds	Differentiate between a saturated and unsaturated compound.	Examine formulas of saturated and unsaturated compounds to determine the differences.
Hydrocarbons		
Alkane Series	Write the general formula for the members of the alkane series. Name compounds based upon their molecular formulas. Draw the structural formulas for selected alkanes.	Practice naming and drawing structural formulas for members of the alkane series.
Alkene Series	Write the general formula for members of the alkene series. Write the structural formulas for selected members of the alkene series.	Practice writing the structural formulas for members of the alkene series. Relate the properties of the series to society's uses of the compounds.
Alkyne (acetylene) Series	Write the general formula for members of the alkyne series. Identify the uses of alkynes in our society.	Practice writing and recognizing the structural formulas for selected members of the series. Relate their properties to their uses in our society.
Other Classes	Identify our uses for members of the following classes of organic compounds: alcohols, ketones, ethers, organic acids and esters.	